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Agricultural Research

Heading Cattle Ticks Off at the Border

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USDA, Military Continue War on Insects

The Cold War may be over, but the war against insects isn't.

Mosquitoes, ticks, flies, and other pests continue to spread diseases throughout the world—posing a threat to our soldiers on military missions.

Last year, the World Health Organization predicted that by the year 2010, 4 million people will die each year from the top five tropical diseases unless new drugs and other controls are developed. Four of these—malaria, leishmaniasis, sleeping sickness, and lymphatic filariasis—are spread by flies or mosquitoes.

Malaria, still top killer among the tropical diseases, infects an estimated 300 million people worldwide, according to a 1992 WHO report. The WHO said malaria poses a threat to 40 percent of the world's population.

We in the United States are fortunate to be generally free of malaria and other tropical diseases. But when our soldiers are sent to foreign lands, they are exposed to numerous insects and the exotic diseases they carry.

Helping protect servicemen and women against disease was one of the main reasons for the birth of cooperative research between the U.S. Department of Agriculture and the military. It began in 1942, when USDA offered its scientific expertise to help develop protections for soldiers against insectborne diseases and stored-product pests. One of the biggest success stories coming from that research was the 1950's discovery of the insect repellant called deet—now the active ingredient in nearly all commercial insect repellants.

The cooperative relationship between USDA and the Defense Department remains today—and the benefits are continuing for our soldiers. During both Operation Desert Storm against Iraq and the Somalia mission, our soldiers used a cream containing deet to protect against mosquitoes that are malaria vectors, sand flies carrying leishmaniasis, and other insects. In Somalia, uniforms, tents, and bed netting treated with the insecticide permethrin offered added protection.

Our scientists are building on earlier findings. They are continuing to synthesize and screen new potential repellants and insecticides—for mosquitoes, ticks, flies, and other insects—that are safe and effective in any environment. They're also planning field trials this year on a potential biocontrol for house flies and another for mosquitoes that transmit yellow fever, dengue, and malaria.

Indoor insects such as cockroaches and fleas—both of which contribute to allergy problems and could play a role in disease transmission—have also been targeted with repellants, insecticide baits, and by managing airflow and other environmental factors inside buildings. ARS plans to seek approval for new fire ant repellants—and continues to study a biocontrol organism that reduced fire ant populations by 94 percent under field conditions in Argentina.

We're also developing computer models to predict outbreaks of malaria, dengue, Lyme disease, and other insectborne diseases. This will help military medical personnel track insect and disease trends in foreign countries and better plan protective measures for our troops. In addition, genetic "fingerprinting" research on anopheline mosquitoes has helped in identifying those species most likely to transmit malaria.

Our research to aid the military extends beyond medical and veterinary entomology. Our scientists are also studying ways to stop stored-product insects—the kinds that infest grain bins and contaminate food supplies. And we're working on improved packaging to keep insects from eating a soldier's well-earned meal or from destroying uniforms, blankets, and other equipment held in storage anywhere in the world.

These recent accomplishments and others were highlighted in January during the Armed Forces Pest Management Board's annual meeting to review USDA pest management research of interest to the military. It was clear from that meeting that though we've made great strides over the years, the insect war has, indeed, outlasted the Cold War—and that we have to keep fighting if we're going to stay one step ahead of the next potential insect attack.

Ralph Bram
ARS National Program Leader
Medical and Veterinary Entomology

Agricultural Research

Cover: At the Rio Grande, Robert Rodriguez (left) and Horico Garza, of USDA's Animal and Plant Health Inspection Service, search for livestock that may be carrying ticks. Cattle fever ticks have been eradicated from this country since 1943 except for a narrow strip along the border. Photo by Scott Bauer. (K5439-20)

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TICKED OFF!

SCOTT BAUER

APHIS riders Robert Rodriguez (right) and Horico Garza patrol for stray or smuggled livestock in the cattle fever tick quarantine area along the U.S.-Mexico border. (K5439-12)

Are you bugged by ticks? ARS researchers in several locations ranging from Texas to Florida to Maryland are. And they're concerned about the diseases ticks spread to humans and cattle.

In reality, ticks aren't actually bugs; they're bloodsucking parasites related to spiders. Favorite hosts of various ticks include dogs, cattle, deer, and other wildlife.

One species in the Northeast, the deer tick (formerly *Ixodes dammini;* now *I. scapularis*), feeds mainly on deer and is known for transmitting the agent that causes Lyme disease in humans.

In 1992, the Centers for Disease Control cited 9,677 cases of Lyme disease reported in 45 states. Generally, the Northeast has 80 percent of the cases, the upper Midwest has between 10 and 15 percent, and California reports about 5 to 6 percent a year.

"Lyme disease occurs mainly in suburban areas with an overabundance of deer. Something has to be done about deer, because the adult ticks thrive on them. Ideally, we'd like to eliminate the deer ticks," says Durland Fish, an entomologist with the New York Medical College in Valhalla who is doing cooperative studies with the Agricultural Research Service.

That's exactly what scientists in the ARS Tick Research Unit in Kerrville, Texas, had in mind when they developed a deer treatment station to attract and dose deer with pesticide applied to the animals' haircoat.

In Texas, deer are hosts to another type of tick—the cattle fever tick. These ticks don't transmit Lyme disease, but their bite on cattle once nearly ruined the southern cattle producing industry.

Although cattle fever ticks were eradicated from the United States outside a quarantine zone, some outbreaks still occur in south Texas. ARS entomologist J. Mathews Pound,

at Kerrville, believes these outbreaks are explained by the large deer and elk populations in pastures.

According to Pound, cattle fever ticks were recently found on deer in a pasture that had been vacated for over 5 months.

"If there are no cattle, the ticks should die out, but they survive nicely on deer. It only takes one deer going back and forth across the Rio Grande River south of Laredo to explain the outbreaks of ticks we've seen in empty pastures."

But wild deer and other animals can't be rounded up and dipped like cattle. So Pound and ARS agricultural engineer J. Allen Miller, along with technician Craig A. LeMeilleur, tackled the problem of getting deer to cover their body parts in pesticides.

L.R. HILBURN

Lone Star tick, a species implicated in the transmission of human ehrlichiosis disease agent along the Texas-Mexico border.

The researchers designed a feeder that would apply pesticides to the animals that visit it. They are now in the process of getting a patent on the invention, which they call "the four-poster" because the paint rollers positioned on each corner make it resemble a bed.

Setting up a small laboratory in an isolated trailer equipped with remote video recorders and monitors, Kerrville scientists began to entice deer at the Kerr Wildlife Management Area to feeders loaded with whole-kernel corn. The feeders were designed so that animals would have to rub their heads and necks against the paint-roller pesticide applicators. The pesticide mainly covers these areas, where ticks are known to congregate, and is spread from there to other parts of the body by the animals' grooming habits.

J.M. POUND

White-tailed deer: Large numbers of ticks not only cause itching and blood loss, but may result in swelling and severe inflammation of the ears.

The feeders could also be used to apply topical pesticides to other animals, such as red deer, antelope, elk, sheep, goats, pigs, and cattle.

In Kerrville, where experiments with pesticides are conducted behind game-proof fences, the researchers are developing more ways to reduce the feeding of ticks on deer.

One approach is to use a systemic pesticide such as ivermectin, that can be administered orally. Miller, Pound, and John E. George, another Kerrville entomologist, initiated studies using ivermectin-medicated corn.

"After deer eat ivermectin in corn, ticks stop feeding and die. Ivermectin is used on U.S. livestock for controlling several parasites, and it's used for controlling botflies on reindeer," says Miller.

In cooperative studies with U.S. Army researchers, Miller formulated ivermectin-laced peanut butter and rolled oats to feed laboratory hamsters. Findings showed that ticks that transmit Lyme disease are susceptible to ivermectin treatments. These studies demonstrated the potential for using the medicated baits to control ticks on rodent hosts of immature ticks in the Northeast.

The medicated bait approach could also be used on cattle fever ticks on wild deer, elk, and other exotic animals that may serve as marginal hosts for the ticks. Last year the researchers, in cooperation with ranch owners, constructed special feeders to attract elk, the animals living on the ranch that were responsible for supporting a low-level tick population.

The privately owned Apache Ranch, located 40 miles north of Laredo near the Rio Grande River, has had frequent cattle tick infestations," says Pound.

So the scientists set up feeders filled with ivermectin-treated corn and placed it at a level appropriate for elk, but too high for other game to feed on the bait.

SCOTT BAUER

SCOTT BAUER

J M POUND

Top: Near Kerrville, Texas, Chris Santos loads corn into a feeder designed to treat white-tailed deer for ticks. (K5437-17) Center: Entomologist Mat Pound focuses a laser-infrared-equipped, day-night camera that permits round-the-clock recording of deer feeding. (K5434-6) Bottom: Temporary fluorescent markings, transferred from the feeder rollers, show scientists exactly where acaricide contacts the deer.

Pound reports, "The last tick was found on this ranch in May 1992. This is the longest since 1956 that the Apache Ranch has been tick-free."

Researchers in Maryland have already borrowed the feeder idea.

ARS entomologist Edward T. Schmidtmann in Beltsville set out several units of the prototype deer treatment station baited with corn and apple aromas to attract deer.

"We need to determine what attracts the deer, how many come to the treatment station, how often, for how long, and at what intervals," says Schmidtmann.

Tick Tracking

To observe the deer response to the treatment stations, the Beltsville researchers plan to implant small electronic transponders in deer to record their presence at the stations and send data into a computer database. Infrared cameras monitor deer activity at night.

The scientists are targeting the adult stage of deer tick for control because the adults depend on white-tailed deer for reproduction. Ninety-five percent of deer ticks' reproductive success is from feeding on white-tailed deer.

"Ultimately, treating deer to control ticks will be more effective in reducing tick density than eliminating deer from an area. That's because the treated deer will pick up ticks and remove them from the environment, rather than leave them behind to find another host," says Schmidtmann.

Gary A. Mount, who is with ARS' Medical and Veterinary Entomology Research Laboratory in Gainesville, Florida, also notes the increasing deer population and its role in supporting deer tick populations.

He and coworkers Danel G. Haile and Eric Daniels developed LYMESIM, a computer model that simulates deer tick populations and transmission of the Lyme disease agent.

"With LYMESIM, we can study the effects of weather, habitat, and density and type of host animal on tick population growth," says Mount.

A few years ago, the Gainesville scientists developed a model and a handbook to assist park managers in deciding on the best control measures to use against the Lone Star tick in recreational areas. The Lone Star tick attacks humans and is a pest of domestic livestock and pets.—By **Linda Cooke,** ARS.

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Cattle Take a Dip at the U.S. Border

As cattle enter this country from Mexico, they're routinely dipped in an organophosphate pesticide, coumaphos.

"It's our only practical defense against the ticks that once nearly ruined our southern cattle industry," says John E. George, who is in charge of tick research at the Knipling-Bushland U.S. Livestock Insects Research Laboratory in Kerrville, Texas.

But cattle fever ticks in Mexico have developed genetic resistance to coumaphos, the only approved chemical used in the cattle-dipping vats at the U.S.-Mexico border.

The cattle fever tick earned its infamous reputation in the late 1880's, when Texas ranchers drove their herds to northern markets through Arkansas, Missouri, and Kansas. Texas cattle had an acquired immunity to the disease—bovine babesiosis—caused by these ticks. But the cattle drives carried it northward, to vulnerable northern herds.

After a 36-year campaign, cattle fever ticks were finally declared eradicated from the United States in 1943. Today, the only remaining area where these ticks are found is a narrow strip of land along the Texas-Mexico border that has been quarantined ever since 1938.

If cattle fever ticks are found on cattle near the quarantine zone at any time, ranchers have only two options: either dip the cattle every 2 weeks or remove them from the pastures, for a quarantine period of from 6 to 9 months. If they opt to dip their cattle, ranchers with large herds could face staggering costs.

"The average cost to repeatedly round up cattle and dip them is about $125 per head for a 180-day program," says ARS's J. Allen Miller.

The Veterinary Services Branch of USDA's Animal and Plant Health Inspection Service (APHIS), in

SCOTT BAUER

After a 36-year campaign, cattle fever ticks were finally declared eradicated from the United States in 1943. Today, the only remaining area where these ticks are found is a narrow strip of land along the Texas-Mexico border that has been quarantined ever since 1938.

Quarantined cattle going through a tick treatment bath at an APHIS facility in McAllen, Texas. (K5442-8)

cooperation with the state of Texas, oversees a tick eradication program to prevent the reintroduction of cattle fever from ticks on cattle that stray or are smuggled into the United States, or that are presented for importation from Mexico.

Each year, about a million head of Mexican cattle are exported to the United States. Each animal receives both a visual and hands-on inspection, or "scratch," and is dipped in coumaphos before entering this country. If even one tick is found, the laborious inspection/dipping process starts over again.

APHIS monitors about 50 concrete dipping vats in the quarantine zone and at other U.S. ports of entry. USDA has supported this program since 1938, says Ralph A. Bram, ARS national program leader for medical and veterinary entomology.

"If reintroduced to the United States, cattle fever ticks and the disease they carry would have devastating effects on beef and dairy farming all across the southern states," says Bram.

But problems have come to be associated with dipping vats. As the materials in the vats age, bacterial organisms convert the coumaphos into potasan. This compound is said to be more toxic to cattle, says microbiologist Jeffrey S. Karns at the ARS Soil Microbial Systems Laboratory in Beltsville, Maryland.

So researchers at ARS' Cattle Fever Tick Research lab in Mission, Texas, send samples from dipping vats to the Beltsville scientists for analysis of coumaphos and potasan concentrations.

APHIS continually checks the vats for the amount of sediment, potasan, and numbers of cattle that have been dipped. Once the level of potasan reaches 0.03 percent, the material in the contaminated dipping vat is removed and disposed of appropriately. The vat is then recharged with approved amounts of water and fresh coumaphos.

SCOTT BAUER

Entomologist Elmer Ahrens (left) and animal caretaker Adolfo Pena inspect for cattle fever ticks. (K5441-1)

Microbiologist Daniel R. Shelton, who is at the Environmental Chemistry Laboratory in Beltsville, discovered that potasan was formed anaerobically (without air) in the vats. To solve the potasan production problem, Shelton found that dropping the pH level of the vat to below 5.5 prevents the formation of potasan.

"We add a phosphate fertilizer to lower the pH. This inhibits the growth of anaerobic microbes responsible for potasan formation," says Karns.

Now, the acaricide in the dipping vats needs to be changed only once every 2 years," says Ed Bowers, assistant director of field operations for APHIS' tick eradication program in the quarantine zone.

And for safe disposal of spent dipping vat contents, Karns and Shelton have discovered several bacteria that degrade coumaphos into harmless material.

Meanwhile, ticks in Mexico have been getting tougher. In the early 1980's, tick control programs in Mexico mistakenly began using low doses of coumaphos against the cattle fever tick.

"As a result of continued exposure to low doses, the Mexican ticks have genetically changed to resist coumaphos' action. But while resistant ticks have been found in parts of Mexico, U.S. ticks in the quarantine zone are still highly susceptible to coumaphos," says George.

APHIS inspectors immediately send a sample of any ticks they collect to the ARS laboratory in Mission, where ARS entomologists Ronald Davey and Elmer Ahrens check them for resistance.

"We've found no resistant ticks from these collections," says Ahrens.

To evaluate levels of resistance, the Mission researchers are rearing small numbers of a resistant strain of ticks from Mexico under strict isolation at the quarantine facility. And Kerrville scientists are developing a field detection kit to identify the resistant ticks in Mexico, but this could take another 3 years.

The initial step, however, has been achieved by ARS molecular biologists L. Carmen Soileau and Felix Guerrero in Kerrville. They have isolated the first tick gene thought to be involved in pesticide resistance—the gene that governs acetylcholinesterase production.

This represents a significant accomplishment," says George. "In the resistant tick, we suspect that the gene coding for acetylcholinesterase may have become altered to block the action of coumaphos."

Kerrville researchers have made a genetic library of the DNA from susceptible cattle fever ticks and are now looking for the complementary gene in resistant Mexican ticks. Making a DNA probe will help identify the resistant ticks faster and more economically.—By **Linda Cooke,** ARS.

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Small Is Beautiful When It Comes to Apple Trees

RICHARD NOWITZ

Plant physiologist Miklos Faust inspects the smallest apple tree produced so far at the Beltsville Agricultural Research Center. The internodes of this tree are about one-eighth inch as compared to about 1 inch for an average apple tree. It is too small for commercial production. (K4048-2)

Although the tree has been growing in the field for 9 years, this newest introduction to the ARS apple orchard in Beltsville, Maryland, is only about 5 feet tall.

"But, that's okay," says plant physiologist Miklos Faust, "because it's a healthy, productive tree."

It and two other dwarf apples were released to plant breeders and other researchers in May 1993.

According to Faust, these new pint-sized trees—70 percent smaller in height and spread than a normal apple—are intended for breeding into future commercial varieties.

And, he cautions, although they're a tempting size for home gardeners, much work has to be done yet before fruit flavor and other desirable characteristics are incorporated into varieties suitable for a backyard orchard.

The new Golden Delicious type dwarfs, selected by Faust, came from breeding crosses made in 1965 by horticulturist Howard J. Brooks, now the ARS associate deputy administrator for plant sciences.

The tallest of the dwarfs grows to only about 10 feet, a great change from years past when apple trees could reach a towering 50 feet.

"One of the difficulties with tall fruit trees is harvesting," Faust says. "Years ago, growers used to sink pegged wooden poles in the ground beside the trees so harvesters could climb to the top to reach the fruit. Ladders to reach such heights were too heavy and cumbersome to bring into the orchard.

Dwarf trees have many advantages, including easier pruning, spraying, and harvesting," he says. [See "Dwarf in Size, Giant in Productivity," *Agricultural Research*, May 1991, pp. 13-14.]

One reason dwarf trees produce relatively more fruit is that the extra carbohydrates that would normally have been expended on vegetative growth goes instead into the making of fruit.

And sunlight, which is responsible for photosynthesis, penetrates a dwarf tree better than a normal size tree, since it doesn't have to filter through so many branches. The increased light also enhances the fruit's sugar content and flavor.

Apple trees rarely ever reproduce true from seed," Faust explains.

"This means that a tree grown from seed won't look anything like its parents. Also, fruit from the new tree will be completely different."

To remain true to a particular variety, the apple must be propagated asexually, which means the tree must be regrown from one of its own buds or twigs. This is true, Faust says, whether the tree is regular size or one of the new dwarfs.

Although a grafted apple tree looks like any other tree—with roots, stems, leaves, flowers, and fruit—it is very different.

"Unlike oaks or maples that grow from seed and stand on their own roots, an apple tree is grafted onto a desired rootstock," explains Faust.

"It is a composite tree because it is made of two or three parts—either of root and scion (young twig), or of root, interstem, and scion. The interstem, a piece of stem that will form the trunk of the new tree, is grafted onto the rootstock. Then the scion of the cultivar is grafted onto the stem piece."

Present-day dwarf trees are produced by grafting standard-size trees to dwarfing rootstocks selected in the 1930's in England.

Propagation by grafting, Faust says, is just an ancient form of cloning. With modern cloning, sometimes called tissue culturing—growing a tree from just a few cells—apple cultivars can be regenerated without grafting and the trees grown on their own roots.

"But this creates a problem by introducing an unknown factor, for we know nothing about the roots of the cultivar itself. Until now we have grafted apple varieties onto rootstock that came, in some cases, from 100-year-old varieties," Faust explains.

"Even new varieties produced by scientific breeding are immediately grafted onto well-known, established rootstock. We know how to irrigate and how much fertilizer to use to produce a certain amount of growth from these rootstocks."

So producing apple trees by tissue culture means that each new apple variety—growing on its own roots, dwarf or not—must be evaluated before it can be recommended for commercial planting.

The new dwarfs do not rely on special roots for their size. They are genetic dwarfs in which the dwarfing occurs in the tops of the trees, not in the roots. The key to their compact size is the short distance between nodes—the places along a tree branch from which leaves grow. While the internodes, or distance between nodes, of a standard tree are about 1 inch, those of the new genetic dwarfs range from one-sixteenth to one-half inch in length.

RICHARD NOWITZ

Seven-year-old semidwarf apple trees propagated from tissue culture at the Beltsville Agricultural Research Center. (K4049-5)

The new releases are bred from a cross of Goldspur and Redspur Delicious apple trees. Of Brooks' original cross, four selections were allowed to grow at a location where they were not likely to cross-pollinate with any other apples.

From the intercrossing of the four selections, 2,000 seeds were germinated and planted. It was from these seedlings that the new introductions came. The three—as yet unnamed, but numbered as selections US B1, US B2, and US B3—were chosen for their dwarf characteristic and show the following traits:

- **US B1**—Most dwarf of the three selections, this tree grows to only about 5 feet in height. Compared to normal trees, it has short internodes that shorten even more as temperatures warm in the spring. As internodes shorten, leaf area decreases. This is a reproducible characteristic. The tree keeps forming internodes and new leaves until very late fall. The apples are fair quality Golden Delicious type.
- **US B2**—This dwarf tree reaches about 7 feet. Internodal length is not quite as short as that of US B1. Its Golden Delicious type fruit retains green color for a long time and matures in late October.
- **US B3**—Largest of the three introductions, this tree grows to about 10 feet. Internodal length is about half that of a normal size tree. The medium-quality fruit, which ripens late, is green and has a woody taste.—By **Doris Stanley**, ARS.

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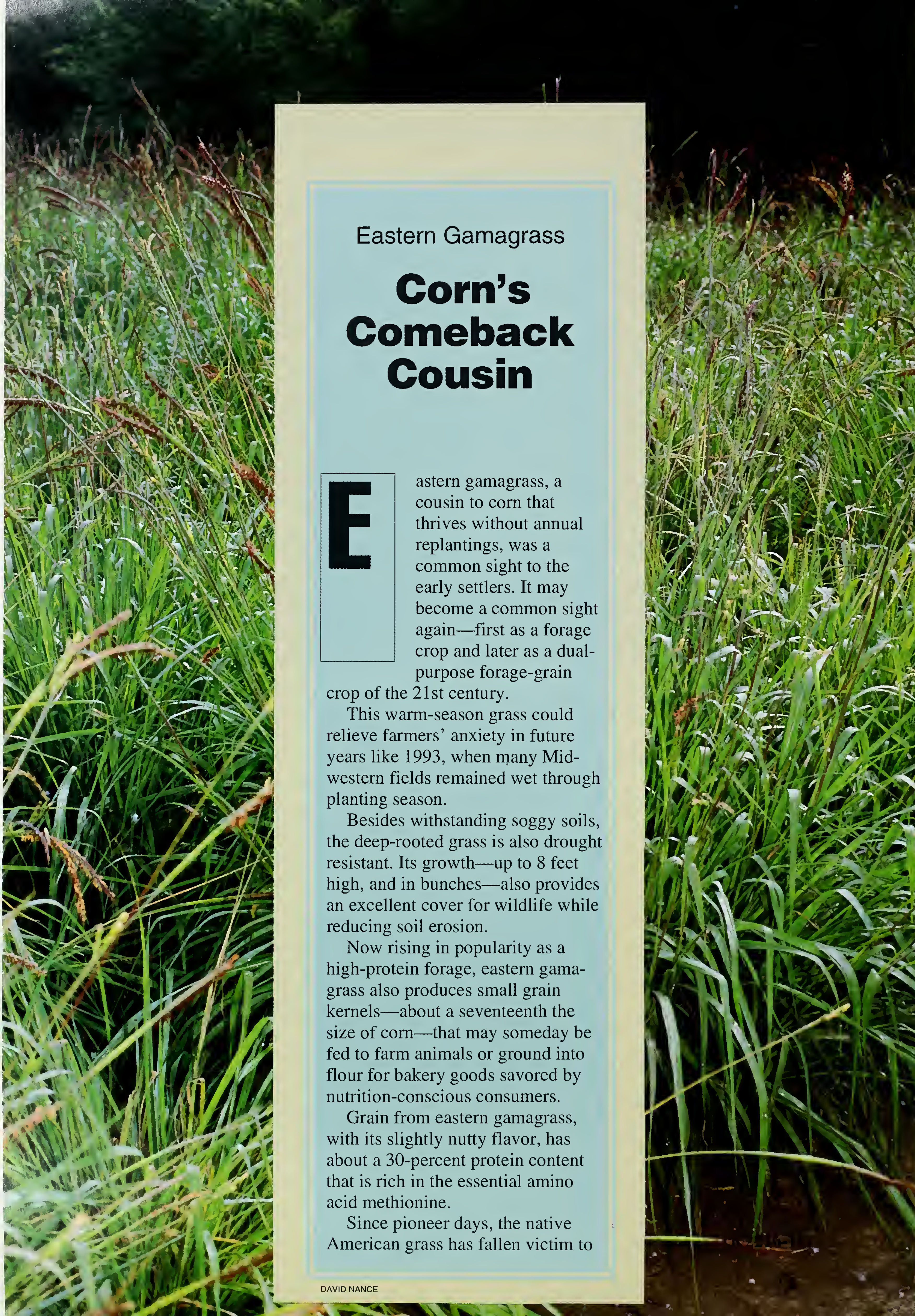


DAVID NANCE

Eastern Gamagrass

Corn's Comeback Cousin

Eastern gamagrass, a cousin to corn that thrives without annual replantings, was a common sight to the early settlers. It may become a common sight again—first as a forage crop and later as a dual-purpose forage-grain crop of the 21st century.

This warm-season grass could relieve farmers' anxiety in future years like 1993, when many Midwestern fields remained wet through planting season.

Besides withstanding soggy soils, the deep-rooted grass is also drought resistant. Its growth—up to 8 feet high, and in bunches—also provides an excellent cover for wildlife while reducing soil erosion.

Now rising in popularity as a high-protein forage, eastern gamagrass also produces small grain kernels—about a seventeenth the size of corn—that may someday be fed to farm animals or ground into flour for bakery goods savored by nutrition-conscious consumers.

Grain from eastern gamagrass, with its slightly nutty flavor, has about a 30-percent protein content that is rich in the essential amino acid methionine.

Since pioneer days, the native American grass has fallen victim to

◀ **Seed head of a high-producing mutant of eastern gamagrass. (K2216-1)**

▶ **Seed heads of another variant eastern gamagrass. (K2216-20)**

the plow and overgrazing. Its comeback awaited scientists' tackling some major bugaboos, such as poor seed yield.

"We still have a long way to go before we have a dual-purpose grain and forage crop, but it can be done," says Chester L. Dewald, an ARS agronomist in Woodward, Oklahoma.

Even as crosses between eastern gamagrass and corn can lead to modern corn hybrids with many new genes for plant disease resistance, such crosses could also benefit the grass, according to Dewald.

"Although genes from corn can't be expected to make gamagrass seed yields match those of corn—at least not anytime soon—gamagrass is cheaper to grow because annual replantings aren't needed."

"And," points out Gary Fine, former Plant Materials Center manager for USDA's Soil Conservation Service in Manhattan, Kansas, "lowlands along creeks and rivers are often too wet to support annual crops such as corn but are ideal sites for gamagrass."

In 1974, SCS released to plant breeders the first experimental strain of eastern gamagrass germplasm, PMK-24, developed from an assemblage of seed collections from 70 locations in Kansas and Oklahoma. The same composite germplasm was released as a variety named "Pete" in 1988. By then the word was out that ruminant animals find eastern gamagrass highly palatable—the "ice cream" of forage crops. Cattle tend to overgraze it in preference to other grass species.

Rotational grazing among pastures with pure stands helps ensure vigor and make the most of the forage produced. It prevents livestock from overgrazing lush new growth while leaving tall clumps of old growth.

Dan Shepherd of Shepherd Farms, Inc., Clifton Hill, Missouri, rotates about 325 adult buffalo through 3 pastures totaling 135 acres on Chariton River bottomland. Starting when growth reaches a height of 2 feet or more in mid-May, he lets the animals graze it down to a height of about 10 inches.

From a nutritional perspective, there's good reason to let livestock feast on the forage—its protein content is similar to alfalfa's. As a hay, it may have a protein content up to 17 percent if harvested at about 6-week intervals, or just before seed heads appear. Dewald says, "Alfalfa may be the queen of legume forages, but eastern gamagrass is the queen of grass forages."

According to him, another reason farmers find gamagrass attractive is that it grows well on a wide variety of soils. It may thrive for several decades on wet or poorly drained soils where alfalfa stands would not persist more than 3 or 4 years.

At a 1993 field day held at Shepherd Farms, a University of Missouri forage specialist pointed out that high levels of phosphorus are not needed for eastern gamagrass to grow well, whereas each ton of hay harvested has generally taken up about 30 pounds of it.

And researchers may someday find a way to continually renew the soil with nitrogen for eastern gamagrass with interplanted legumes.

The popularity of eastern gamagrass is rising. In response to progress researchers have made in increasing seed yields and identifying management options, several growers in Nebraska, Kansas, and Missouri are now producing enough of the seed to adequately meet farmers' requirements.

Much research remains to be done, however, on the problem of seed shattering before and during harvest.

Today's harvestable seed yields are typically about 100 pounds per acre, although yields of 250 pounds are possible under ideal conditions. These include adequate moisture and fertility to support optimal development of reproductive seed stalks. Also, moderate temperature and humidity favor production and disper-

DAVID NANCE

Agronomist Chester Dewald believes eastern gamagrass can be a dual-purpose crop—grain or forage. (K2216-12)

sion of viable pollen and promote the receptivity of silks to pollen during the flowering season.

Making a Good Grain Better

The prospect for much improved seed production began in 1981, when SCS' Robert Dayton contacted Dewald. Dayton had discovered an eastern gamagrass plant with an unusual seed head: The mutant's male flowers had become feminized and produced seed.

Dewald found that the seed count on each head of the mutant plants had increased by about 2,500 percent. But because the seeds were small, increased pounds of seed per plant ranged only between 300 and 500 percent.

From these so-called gynomonoecious plants with the sex-reversal trait, Dewald is screening for agronomic traits such as disease resistance, to develop new germplasm lines.

And some desired traits may be introduced to gamagrass from corn. But a viable cross between the two species can involve time-consuming and expensive techniques such as embryo rescue, says ARS cytogeneticist Bryan K. Kindiger, Woodward.

Often unsuccessful, embryo rescue involves cutting away part of a meager starch portion of a hybrid embryo that's incapable of fully developing on its own and then artificially feeding the embryo with agar, a nutrient-rich plant gel.

Kindiger and retired ARS cytogeneticist Jack B. Beckett have found varieties of popcorn that can be used as a "bridge" between the two distantly related parents in this wide-cross breeding program. Plants from popcorn-gamagrass crosses often produce ears with more than 50 plump kernels—enough for continued research.

In other studies, Kindiger and Dewald have identified a refrigeration method that keeps gamagrass pollen viable for more than 10 days. Pollen of plants that differ in flowering dates thus becomes available to a greater diversity of crosses between strains or related species.

After many desired traits are bred into gamagrass, scientists hope to lock in genes for succeeding generations with genes for another trait, apomixis—asexual reproduction through seed. [See "Apomixis. It Could Revolutionize Plant Breeding," *Agricultural Research,* April 1993, pp. 18-21.] In apomictic plants, embryos grow from cells without being fertilized by pollen from males, thus preventing introduction of undesired traits.

Transferring desirable genes from corn to gamagrass has been made much easier by the advent of genetic engineering and high-tech innovations in conventional breeding.

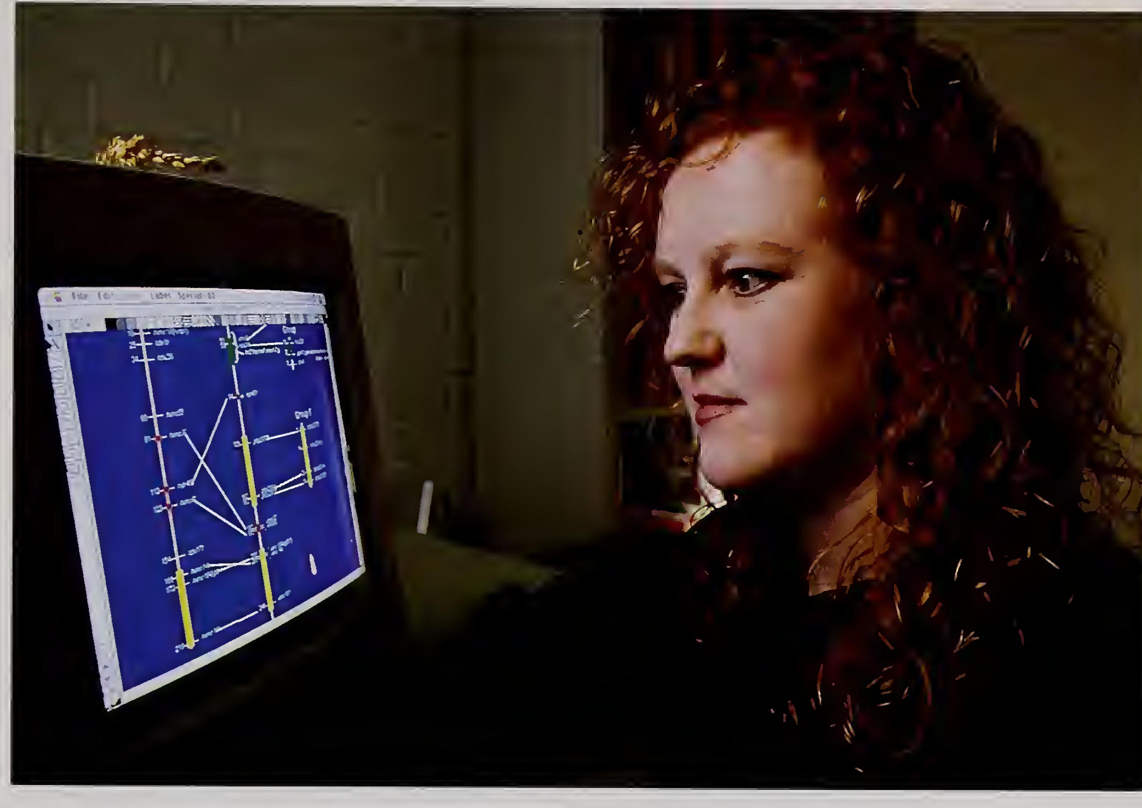
A member of the Woodward team stationed at the University of Missouri-Columbia, ARS molecular geneticist C. Ann Blakey, used restriction fragment length polymorphism and polymerase chain reaction technologies to identify groups of genes in gamagrass that are remarkably similar to those found in corn.

"The genomic similarity between corn and eastern gamagrass may provide opportunities to endow either one with desirable traits of the other," she says.

Nutritionally, It's First Class

The overall protein content of gamagrass grain is about three times that of corn and twice that of whole wheat, says ARS chemist Robert Becker of the Western Regional

JIM CURLEY



Molecular geneticist Ann Blakey checks for genetic similarities between eastern gamagrass and corn. (K5443-1)

Research Center, Albany, California. In preliminary nutritional studies, he and his colleagues of the Center and the University of Nebraska found that gamagrass seed, with its abundant stores of unsaturated fatty acids—primarily linoleic acid—contained more than half again as much vegetable oil as ordinary corn.

The scientists also concluded that gamagrass seeds may have less of the trypsin inhibitor antinutrient than corn. Their studies showed that flour beetle larvae fed uncooked gamagrass flour supplemented with brewer's yeast grew larger than larvae fed diets containing uncooked corn or whole wheat flours.

Having done preliminary baking studies, the ARS scientists at Woodward foresee the possibility of specialty breads from wheat-gamagrass flour blends.

Once a satisfactory way is developed to remove the hull surrounding the seed, gamagrass seed could be processed for flour or oil with technologies that are currently available.

The tightly bound hull also gets in the way of rapid germination of newly planted seed.

Dewald and Victor A. Beisel of Aaron's Engineering, Fargo, Oklahoma, are developing a pneumatic dehuller. The device drives seeds against a slanted surface with compressed air to shatter the hulls. Mechanical dehulling vastly improves germination but still falls well short of hand-dehulling.

In other studies, Kindiger found that applying a 30-percent hydrogen peroxide solution to dehulled seed increased the number that germinated. Untreated seed has an average germination of less than 10 percent, while the treated averaged 70 percent.

In nature, variability in the degree to which hulls protect seed from fungi and insects ensures that at least some of the seed will germinate at a good time for the plant to survive.

However, "When we remove the hulls to increase germination rates, we run the risk of creating a feast for pests," Dewald says. He envisions artificially encapsulating dehulled seeds—perhaps with starch and agricultural chemicals—to help boost seedlings with a healthy start.

Meanwhile, commercial seed producers try to help seeds germinate quickly after planting through stratification—a wet-cool storage treatment for 6 to 8 weeks before shipment to the grower.

With research done by ARS and other public and private entities working together, eastern gamagrass has tremendous potential," says plant materials specialist Erling Jacobson of the SCS Midwest National Technical Center in Lincoln, Nebraska.—By **Ben Hardin,** ARS.

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High "BUN" Level a Sign of Protein Waste

A simple blood test can help cattle producers fine-tune their herd's feeding regimen, leading to more beef for less money. The blood test in question checks blood urea nitrogen (BUN), potentially a telltale sign that supplemental protein in the herd's diet is being wasted by the animals' bodies, says ARS animal scientist Andrew C. Hammond.

"Ruminant animals such as cattle can take nonprotein nitrogen and make protein out of it, so nitrogen can be a protein source in a feed supplement," explains Hammond, who is at ARS' Subtropical Agricultural Research Station at Brooksville, Florida.

"Microorganisms in the animal's rumen (stomach) break down the nitrogen, which results in production of ammonia. The microorganisms can then use this ammonia to make protein. But if the diet is too low in calories, the bacteria don't have enough energy to fuel their protein-making activities and you get excess ammonia."

This ammonia builds up, passes through the rumen wall into the bloodstream and is transported to the animal's liver, where it is converted to urea. The urea circulates in the blood to the kidneys and may be excreted with urine or recycled back to the rumen.

"As a result of these metabolic transactions, you can tell whether a diet is optimized for the protein-to-energy ratio by checking the urea nitrogen levels in the blood," says Hammond.

In field tests in Florida in 1991 and 1992, Hammond and colleagues divided about 1,600 pregnant cows into two groups. One group grazed dormant pasture and also received molasses for energy plus a standard amount of a cottonseed cube protein supplement.

The second group ate the same diet, but timing and amount of protein feeding were based on BUN levels of selected cows. Blood samples were taken every 3 weeks from November until April.

Blood urea nitrogen measurements can reveal costly flaws in the herd's feeding program.

"We'd begin cube feeding or increase it when the herd mean sample BUN levels dropped below 7 milligrams per deciliter of blood, or when 25 percent of the cows in the herd sample had a BUN concentration of less than 6 milligrams per deciliter of blood," Hammond recalls. "In the spring, we cut down or withdrew the cube feeding when the herd sample mean BUN concentration was higher than 10 milligrams per deciliter of blood."

The result: The cows whose feeding was guided by blood urea nitrogen concentrations consumed 22 pounds less of protein supplement per animal over the winter period, without affecting calf weaning weights or the cows' ability to become pregnant again the next year.

In another study involving steers and heifers grazing warm-season grasses at Gainesville, Florida, Hammond and colleagues pinpointed 9 to 12 milligrams of blood urea nitrogen per deciliter of blood as a turning point for balanced feeding programs.

KEITH WELLER

A simple blood test that checks the blood urea nitrogen (BUN) levels in cattle can help producers fine-tune their herd's feeding regimen. (K4328-8)

“If the animals’ BUN concentrations are more than 12 milligrams per deciliter of blood, you’re giving them dietary protein their bodies aren’t using,” Hammond notes. “But if their BUN readings are below 9 milligrams per deciliter of blood and you give them more protein, they’ll grow faster.

“This information could be used in a couple of different ways,” Hammond continues. “For example, if we’re conducting a nutrition experiment, quite often blood samples are taken for BUN levels. Afterward, these levels can help us explain the performance of the animal in the experiment.

“The information could be used in a commercial operation the same way. However, it must be remembered that the levels of blood urea nitrogen associated with optimal performance differ among types of cattle and their production situation.

“If a cattle producer has cows that are not in top condition in the winter, the producer could check BUN levels to see whether there needs to be more energy or more protein in the animals’ diet. Purchased supplement is expensive, and protein is a more expensive component of the supplement. Cattle producers don’t want to oversupply, but they don’t want to undersupply, either.”—By **Sandy Miller Hays**, ARS.

Andrew C. Hammond is at the USDA-ARS Subtropical Agricultural Research Station, 22271 Chinsegut Hill Road, Brooksville, FL 34601-4672; phone (904) 796-3385, fax (904) 796-2930. ◆

Toward Retrovirus-Resistant Sheep

Genetically engineered sheep may be the first step toward preventing difficult-to-control viral diseases of livestock that do not respond to vaccines. Caused by slow-growing retroviruses, these diseases have confounded all past methods of treatment.

Ovine progressive pneumonia of sheep is caused by a retrovirus—the visna virus. Its symptoms include encephalitis, pneumonia, and arthritis, and it eventually causes death.

“The sheep get sick because the virus slowly destroys the immune system, leaving the animals susceptible to many normally easy-to-resist diseases,” says ARS scientist Caird E. Rexroad.

“We are trying to build into sheep the ability to ward off the virus. The gene for the virus’ outer coat, the part that the body should recognize as foreign, and the gene for turning the virus on and off were combined and inserted into fertilized sheep eggs.”

The eggs were placed into surrogate mothers that gave birth to three females in which all the body cells contained the new gene construct.

Blood tests have shown that macrophages—a type of white blood cell—in the genetically engineered sheep are manufacturing and secreting the protein for the viruses’ outer coat. Macrophages are the body’s first line of defense against foreign invaders.

“Viruses invade cells by first attaching themselves to binding sites on the cell’s surface. Our strategy is to have the viral protein, produced by the macrophages in the genetically engineered sheep, bind to the cell sites, thereby preventing the virus from locating open binding sites,” says Rexroad.

The retroviruses are slow growing and have “learned” to trick the body’s immune system. They infect the macrophages.

The virus becomes an intimate part of the macrophages, the cells that normally engulf and kill foreign invaders. Once inside the macrophages, they take over the cell genome and force it to produce more virus—eventually killing the cell. “This begins the long, slow process that eventually kills the sheep,” says Rexroad.

Vaccines work by stimulating the production of antibodies against disease agents. However, antibodies normally produced by vaccines against the visna virus have not been effective. “These studies may give us a better picture on how the visna virus affects sheep,” says Rexroad.

The visna virus is transmitted at birth or through nursing or contact with saliva. It is insidious because it often goes undetected, and the farmer loses money for feed and medicine without knowing the cause. “In some areas of the country, as many as 50 percent of the sheep can be infected,” says Rexroad.

“We have not yet infected the sheep with the visna virus because three animals are just not enough to work with. However, we’ve bred the females and are superovulating them—using hormones to produce many eggs. The eggs will be placed into surrogate mothers. Within 1 year, we should have the 30 genetically engineered sheep we need to determine if they are indeed immune to the visna virus.”—By **Vince Mazzola,** ARS.

Caird E. Rexroad is at the USDA-ARS Gene Evaluation and Mapping Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705-2350; phone (301) 504-8534, fax (301) 504-8414. ◆

Cotton Advice You Can Bank On

Computer farming may sound futuristic, but the term describes a direction cotton growers are taking to boost their crop yields and profits.

Consider Mississippi Delta grower Kenneth B. Hood.

He's using a crop management computer program called GOSSYM/COMAX to help him successfully navigate some of the guesswork and govern the costs of growing cotton.

Compatible with most 80386 or 80486 personal computers, GOSSYM/COMAX consists primarily of software called a simulation model and an expert system, says James M. McKinion, who heads ARS' Crop Simulation Research Unit at Mississippi State, Mississippi.

The GOSSYM component simulates or predicts how a cotton plant will grow, based on variety, soil type, temperature, rainfall, solar radiation, and other factors. The model also graphically maps each stage of a cotton plant's growth, allowing the grower to closely watch a crop's overall development.

"A strength of the GOSSYM model is in predicting when there's going to be water stress," McKinion says. "Given data from a National Weather Service forecast, the grower can look at what the weather's going to be for the next 30 days and very accurately predict—to the day—when the cotton plants are going to run out of water."

Now, here's where COMAX comes into play.

Alerted by GOSSYM's simulation of the crop's water needs, the grower then runs COMAX to help decide when, where, and how much to irrigate. If the grower chooses, COMAX can also recommend the timing and application rate for fertilizer or other chemical inputs, such as a growth regulator or defoliant.

"Those things are what determine my profit in more ways than one,"

SCOTT BAUER

Cotton producer Kenneth Hood and his assistant Dee Roberts use the computer program GOSSYM/COMAX that helps them plan irrigation, fertilizer, and defoliant applications as well as forecast harvest dates and yields. (K5349-3)

says Hood, who grows cotton on about 65 percent of his acreage at Perthshire Farms in Bolivar County.

Hood uses GOSSYM/COMAX to help him parcel out only as much of various inputs as his crops actually need for optimum yield. Using fewer inputs means a higher net profit.

"We've actually become better economists and environmentalists because we've learned to spoon-feed our crops," Hood says. "With our fertilizer program, we don't go out there and apply 60 pounds of nitrogen fertilizer when 30 pounds would be enough."

According to McKinion, it's taken over 20 years of collaborative effort to make GOSSYM/COMAX a viable tool for growers. The research was performed by scientists with ARS, the South Carolina Agricultural Experiment Station, the Mississippi Agricultural and Forestry Station, and federal and state Extension Service agencies.

Following its 1984 debut on two farms in Mississippi and North Carolina, GOSSYM/COMAX began sparking interest among growers across the Cotton Belt. By 1991, use of the program had spread to over 100 farms in 12 states, for a total of 179,000 acres.

It's now used by more than 300 growers or crop consultants on over 500,000 acres of cotton in Mississippi, Tennessee, Louisiana, Texas, California, and other states. McKinion says researchers and cotton producers in France, Spain, Greece, and China have expressed interest in collaborating with ARS in adapting the program for research use in their countries.

Counting Up the Cash

In the United States, an annual net benefit of about $25 million can be attributed to the use of GOSSYM/COMAX, McKinion says. And this could be as much as $600 million—if the management system were used on all 13 million acres of U.S. cotton.

He says these estimates are based on data from a recent study published by Texas A&M University that reported on a survey of growers using GOSSYM/COMAX in 1991—some with special training and some without. USDA's Extension Service and the National Cotton Council of America helped compile the survey.

Of the 200 growers surveyed, 79 were trained by specialists with the USDA Extension Service's GOSSYM/COMAX Information Unit (GCIU) in Starkville, Mississippi. They learned to adapt the program to their individual cultural practices, regional climates, and soil types.

Of the 79 with GCIU training, 57 percent hired staff to accomplish the more timely use of field and weather data, which contributed significantly

to their greater yields and/or income per harvested acre.

Thirty-nine trained growers reported an average increase of 131 pounds per acre in cotton lint yield. And 25 reported an average increase of $45 per acre in net income. Separately, it amounted to $54 more per acre for growers with staff help and $37 per acre for those without.

Four of the GCIU-trained growers reported decreased production costs of $18 to $25 per acre, while 14 reported increases of $27 to $33.

None of the growers surveyed had decreased net income.

According to the survey, the main obstacles to using GOSSYM/COMAX that were encountered by some growers were a lack of time for entering field data and nonavailability of relevant data on soil and soil hydrology—the movement of water through the soil.

Hood, who has been using the program since 1986, emphasizes that "the data you get out of GOSSYM/COMAX will be only as good as the data you put into it." And he adds that the time spent collecting and loading field data into the program pays off with more accurate simulations of crop growth and needs.

Growers or consultants with questions regarding the use of GOSSYM/COMAX should contact the GCIU, says cotton agronomist Scott Staggenborg. In addition to an operations manual for new users, GCIU also provides 2-day training sessions during late winter. "And we have advanced training for the more experienced user," he says.

SCOTT BAUER

Soil agronomist Frank Whisler (right) and graduate student Farhad Khorsandi record cotton plant height, nodes, and fruiting sites—a process called mapping—to aid in quality and yield research. (K5348-2)

The WHIMS of Technology

Hood is also cooperating with ARS researchers in field-testing—for its third year—rbWHIMS, or rule-based (W)Holistic Insect Management Systems.

This expert system is designed to help cotton growers manage insect pests such as bollworms, using beneficial insects and fewer pesticide applications.

Growers will be able to use WHIMS to determine where, when, how much, or if they should apply pesticide to the crop, based on the severity of pest populations.

WHIMS is also fitted with an economic package to help growers decide whether spraying is more costly than the damage likely to be caused by a relatively small pest infestation, McKinion says.

The program uses a grower's own field counts—coupled with what is known about a pest's feeding, ecology, and behavior—to make one of three recommendations: scout again in 7 days, scout again in 3 days, or spray.

Data on 13 insect pest species or species groups of the Midsouth are in the system, McKinion says. These include boll weevils, boll/budworms, plant bugs, aphids, whiteflies, mites, and other cotton pests. All told, there are 21 known insect pests of cotton throughout the U.S. Cotton Belt.

WHIMS also keeps tabs on populations of beneficial organisms such as ladybugs, predatory wasps, or fungi that can reduce the need for pesticide applications.

The next step will be to combine WHIMS with GOSSYM/COMAX. Developers hope to make it available to growers by 1995.

"By that time," McKinion says, "we'll have a system that tells the grower how to manage not only water and nitrogen, but also insect pests of the Midsouth, which is the first target area."—By **Jan Suszkiw**, ARS.

James M. McKinion is in the USDA-ARS Crop Simulation Research Unit, Crop Science Research Laboratory, P.O. Box 5367, Mississippi State, MS 39762; phone (601) 324-4375, fax (601) 324-4371. ◆

Leafy Spurge Is Reunited With Old Enemy

An insect that loves to eat leafy spurge, a range weed now infesting 2-1/2 million acres on the Northern Plains, may bring some relief to farmers and ranchers. The weed, *Euphorbia esula L.*, causes more than $100 million in losses each year.

"Leafy spurge is ranked as one of the worst weeds in the Northern Great Plains and Canada, and it's getting worse every year," says ARS plant physiologist Paul C. Quimby, Jr., who is in charge of the Range Weeds and Cereals Research Unit in Bozeman, Montana.

"It expands its infestation by 10 percent annually, essentially doubling its original area about every 7 years. Spurge contains irritating chemicals; cattle and horses generally won't graze on it, and they sometimes refuse to eat nutritious forage growing nearby."

In recent years, ARS scientists have turned to biological control insects to curb spurge's spread.

"About 500 *Aphthona nigriscutis* flea beetles released in one spot multiplied and practically eliminated leafy spurge from an area 18 by 20 yards by the end of the second year. By the third year, the cleared area measured 53 by 59 yards. And at the end of the fourth year, the beetles had cleaned the weed from an area 88 by 100 yards," says entomologist Norman E. Rees, who is also in the Bozeman unit.

Aphthona flava, the copper leafy spurge flea beetle, is so efficient at controlling the weed that it has reduced some infestations from 57 percent of canopy cover to less than 1 percent in just 4 years. The tiny, one-eighth-inch beetle was first spotted in Italy, where it had completely defoliated leafy spurge in some areas.

"This demonstrates that insects are a biocontrol method that works,"

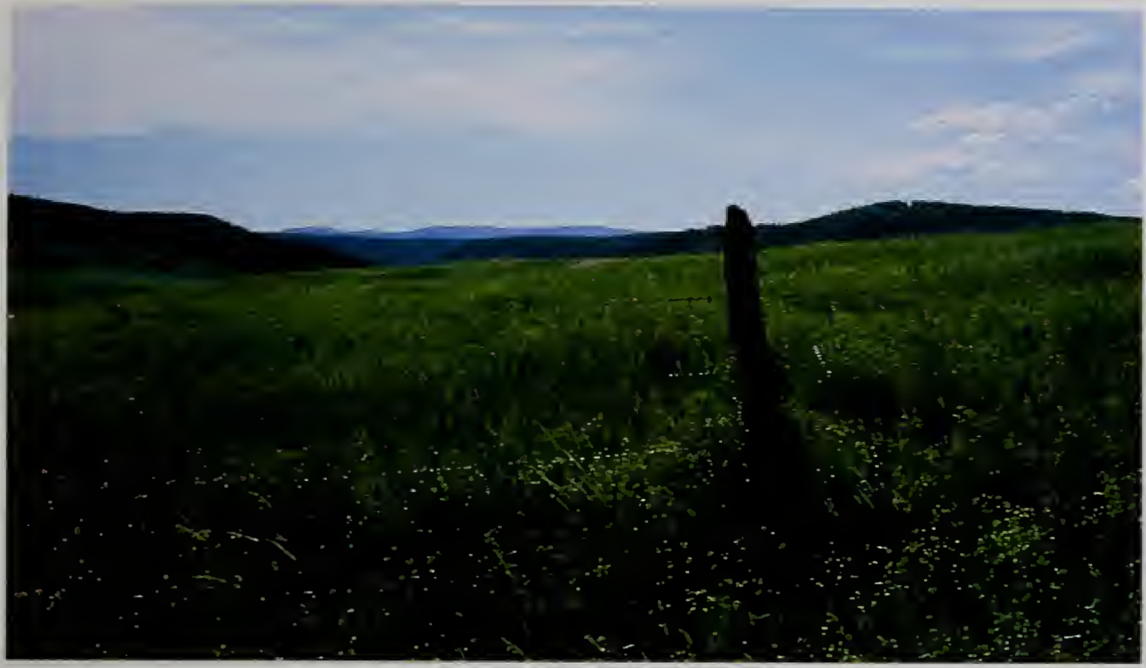
NORM REES

▶ ***Aphthona nigriscutis,*** **a tiny flea beetle that is being used to stop leafy spurge, a weed infesting 2-1/2 million acres of rangeland in the Great Plains.**

▼ **Blossoms of leafy spurge, *Euphorbia esula* L.**

ARS PHOTO

NORM REES



NORM REES

Top photo: Completely covered with leafy spurge, this Montana rangeland was useless for cattle grazing. Bottom photo: Four years later, only scattered spurge plants remain, thanks to *Aphthona nigriscutis* beetles.

says Quimby. "We now need to find ways to get these flea beetles, in combination with other insects, distributed and established over a much larger area so we can control leafy spurge.

"Chemicals are too expensive, at $72 per acre, for temporary control on land that has value only for livestock grazing. Plus, chemicals kill desirable broad-leaf plants. No known approved herbicide has shown any promise in killing 3-year-old and older spurge plants. Some root buds have even sprouted 7 years after the soil was sterilized."

Adds Quimby, "Although *A. flava* and its close relatives are the most successful insects in our arsenal, we need to find many more to control leafy spurge. The adults of these flea beetles eat leaves and flowers, and the larvae feed in the root hairs and yearling roots. We need other insects that bore into stems or eat shoot tips, so as to attack spurge in all possible ways."

Key to finding the right insects is to return to the spurge's native areas. Early settlers in this country probably brought the weed with them among seed stocks from their native European and Asian lands. There, predatory insects had evolved along with the plant, feeding on it and keeping it at low levels.

All insects that are candidates for introduction are carefully tested to make sure they survive only on leafy spurge and not on valuable crop plants or plant species native to North America.

"In our area, *A. flava* likes south-facing slopes, 18 to 20 inches of moisture per year, and generally sunny locations. It doesn't like clay or acidic soils or, possibly, shaded areas. We need to study a whole series of *Aphthona,* as well as other insect species, to find ones that adapt to the many different climate zones where spurge now thrives. Some areas are moist, others dry; some are hilly, others flat. And each zone may be home to spurge plants that are different enough that some species or subspecies of insect won't attack," says Rees.

More recent additions to the program include three *Aphthona* species—*abdominalis* from Europe, plus *chinchihi* and *seriata* from China. After their discovery, they underwent extensive testing by Luca Fornisari at the ARS European Biological Control Laboratory in Montpellier, France. Adult beetles emerged only from leafy spurge and from none of the other 21 key plants that are used to see if the insects might be able to live on plants not being targeted for control.

Then, beginning in 1992, ARS entomologist Neal R. Spencer established three spurge flea beetle species at 389 research sites in eastern Montana and North Dakota, making the first U.S. releases of *A. abdominalis* in 1993. ARS entomologist Robert W. Pemberton and Rees made the first *A. flava* releases in Montana in 1985, after thorough testing by Pemberton in Albany, California.

Now the black dot spurge flea beetle, a close relative provided by Agriculture Canada in 1989, is being pilot-tested at six sites in five states—Colorado, Idaho, Montana, Nebraska, and North Dakota.

The scientists arrange annual events at which weed control officials can pick up *Aphthona* insects, learn about their habitat needs, and later use them to populate new areas throughout the Northern Plains. Rees estimates that more than 500,000 *A. flava* beetles, enough for 1,000 releases, have been distributed from the Bozeman site in the last 3 years.

Evaluation of how good the released insects are at controlling weeds can be time consuming and expensive. Scientists and technicians usually walk into release areas and manually record the distance insects have spread after the initial release and their impact on the plant population.

State-of-the-art remote sensing may make such work easier, faster, and cheaper. Spencer, along with ARS range scientist James H. Everitt and ecologist Gerry L. Anderson, who are in the Remote Sensing Research Unit in Weslaco, Texas, are cooperating in a study near Dickinson, North Dakota.

This past summer they used an airplane flying at 5,000 feet to obtain aerial video and photographic imagery of areas where insects were released to control spurge in the Theodore Roosevelt National Park in North Dakota and on Bureau of Land Management (BLM) areas in Montana. These photos will form the benchmark measurement for subsequent photo comparison. The researchers hope to remotely measure the decreased infestation the insects cause. They will also integrate remote-sensing data with geographic information systems technology to monitor the spread or contraction of spurge-infested areas.

NORM REES

BLM weed scientist Hank McNeel and ARS technician Jennie Birdsall release flea beetles into a leafy spurge-infested meadow.

In Bozeman, ARS plant pathologist Anthony J. Caesar is studying an area in the Lewis and Clark National Forest near White Sulphur Springs, Montana. Leafy spurge infestations there are disappearing without help from researchers.

"We have strong evidence that it is a coral fungus that promotes the effects of other fungi, including *Fusarium* spp. and *Rhizoctonia solani*, in the soil. Together, these fungi create an underground environment that hurts the weed's roots. We will continue the study, hoping to find a way to spread the organisms to other weed-infested areas," says Caesar.

In the infested range, circular areas 15 to 20 feet in diameter are expanding about 1 foot each year, producing land that has only about one third or less of the surrounding spurge populations.

In other "germ warfare," ARS microbiologist Robert J. Kremer in Columbia, Missouri, has identified several bacteria naturally present around the weed's roots that suppress seedling growth. Greenhouse studies show that emergence of weed seedlings was reduced by 50 percent after applying *Pseudomonas fluorescens* and *Flavobacterium*. Also, weed growth was reduced, and the main taproot was half the normal length. Kremer and colleagues plan to move studies to the field this year.—By **Dennis Senft,** ARS. **Linda Cooke,** ARS, contributed to this article.

Paul C. Quimby, Jr., Anthony J. Caesar, and Norman E. Rees are in the USDA-ARS Range Weeds and Cereals Research Unit, Culbertson Hall, Montana State University, Bozeman, MT 59717; phone (406) 994-6850, fax (406) 994-4526.

Neal A. Spencer is stationed at the USDA-ARS Northern Plains Soil and Water Research Center, P.O. Box 1109, Sidney, MT 59270; phone (406) 482-2020.

Luca Fornisari is at the USDA-ARS European Biological Control Laboratory, Montpellier, France; phone 33-67-04-56-00, fax 33-67-04-56-20.

James H. Everitt and Gerry L. Anderson are in the USDA-ARS Remote Sensing Research Unit, 2413 E. Highway 83, Weslaco, TX 78596; phone (210) 969-4824, fax (210) 969-4823. ◆

Science Update on Whiteflies

It sports a new scientific name but hasn't dodged its scientific pursuers. They are sharpening their focus on strategies with potential to control the insect called biotype B of the sweetpotato whitefly (*Bemisia tabaci)* and, by some, the silverleaf whitefly.

In March 1994, an article was published in Annals of the Entomological Society of America that establishes biotype B as a new species, *Bemisia argentifolii.*

This pest—whatever name you use—has afflicted American agriculture since 1986. It transmits plant diseases, feeds on crops, and contaminates them with sticky sugars. Annual income losses are estimated at over $200 million in cotton, melons, and many other crops mostly in Arizona, California, Florida, and Texas.

ARS led development of a coordinated 5-year research and action plan implemented in 1992. This past January, 185 USDA, university, state, and industry experts met in Orlando, Florida, to hold the plan's second annual progress review—and to share new knowledge about whitefly threats.

For example, scientists with the University of Arizona and an ARS lab in Montpellier, France, said the pest is apparently dispersing throughout Asia and within the Mediterranean Basin. They have found it for the first time in Spain, Cyprus, Egypt, and Pakistan.

ARS coordinated the January meeting with other USDA agencies, the University of California, and University of Florida. Some other highlights from the meeting:

Viruses and Other Maladies

Researchers continue identifying new whitefly-transmitted viruses, such as cucurbit yellow stunting disorder virus. It attacks melons and cucumbers but fortunately has been found only in the Middle East. An ARS scientist in Salinas, California, and an Israeli colleague identified it.

New findings about a disorder called squash silverleaf may eventually shed light on its whitefly-related cause and lead to controlling it, perhaps by boosting or regulating the squash plant's defenses. The disorder first appeared in Florida. ARS scientists in Orlando have ruled out viruses, bacteria, and fungi. Their recent measurements of proteins in squash plants fed on by whiteflies suggest the disorder may result from the plants' own response to the insects' chemical secretions.

A Sticky Problem Finally Coming Unglued?

Whiteflies deposit sugars on cotton lint in bolls, and the sticky fiber severely gums up ginning and textile machinery. But the textile industry may see some relief as early as next year. ARS scientists in Phoenix, Arizona, reduced the stickiness up to 82 percent by spraying—just before harvest—a mix of enzymes developed with a private firm.

To Spray or Not To Spray—What, When, Where, and How

Clustering on leaf undersides, whiteflies are partly shielded from insecticides—to which they readily become resistant.

New tests in cotton and other crops support rotating different insecticides and other controls to delay resistance. ARS scientists in Phoenix developed new sampling methods to gauge when whitefly numbers rise enough to merit spraying cotton. Larger studies will validate the methods, which could lead to less insecticide use and higher net returns.

Insecticide covered more of the lower surfaces of cotton leaves in tests of an electrostatic spray charging system designed for aircraft by an ARS scientist in College Station, Texas.

Helping Natural Enemies Turn the Tide

Many fungi and insect parasites and predators have potential as biological controls, but researchers say they will more likely succeed across large areas rather than in single fields. ARS scientists in Weslaco, Texas, are leading an interagency project to design, carry out, and evaluate whitefly biocontrol in the Lower Rio Grande Valley of Texas. At study sites—nine cottonfields within a square-mile area of other crops—the scientists collect extensive data linking populations of whiteflies and their natural enemies to weather, crops, and farming methods.

For biocontrol agents not native to the United States, researchers depend mostly on explorations by ARS scientists based in France. Their collections have concentrated on Europe, the Middle East, and Asia. This year, they will also search—for fungi—in the humid tropics of South America and Southeast Asia.—By **Jim De Quattro,** ARS.

For further information about ARS whitefly research, contact Robert Faust or James Coppedge, USDA-ARS National Program Staff, Building 005, 10300 Baltimore Ave., Beltsville, MD 20705; phone (301) 504-6918 (Faust) or 504-5541 (Coppedge).

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Upcoming in the MAY Issue

- The fungus that caused the infamous potato famine in Ireland 150 years ago is still around and still making trouble.

- An assault with sex pheromones leaves male diamondback moths overwhelmed, confused, and not knowing where to go, say ARS scientists.

- That often odoriferous conglomeration of bedding material and manure known as poultry litter may undergo an environmentally friendly cleanup.